

**A METHOD AND APPARATUS FOR  
PROGRAMMING AN AUTOMATION DEVICE**

**DESCRIPTION**

**Technical Field**

The present invention relates to a control system. More specifically, the present invention relates to a control system on a network having an automation device wherein the operating program for controlling the automation device is to selected from a network device in response to the automation device.

**Related Applications**

5 This application is a continuation-in-part of U.S. Patent Application No.      /     ,      (SAA-34-1) yet to be assigned which is a continuation-in-part of U.S. Patent No. 6,061,603 which is a continuation-in-part of U.S. Patent Application No.09/303,458, which is a continuation-in-part of U.S. Patent Application No.08/927,005. This application is also related to the following, commonly assigned application, entitled "Apparatus for Controlling Internetwork Communications," U.S. Patent Application No. 08/926,837. The contents of these Applications are expressly incorporated herein by reference.

**Background of the Invention**

10 An automation network includes several nodes, i.e., network devices, connected on a network and controlled from one or more locations. Often times, network designers prefer to use similar, interchangeable devices on a network. Depending on the application of an individual, "standardized," network device, certain functions of the device may not be used.

15 20 25 An automation device such as a programmable logic controller (PLC) generally comprises a computer processing unit, RAM, Flash RAM and a network interface. The application program for controlling the PLC is stored in the Flash Ram, typically consuming 256-512K of Flash RAM. The application code is transmitted to RAM at boot up of the automation device. Depending on the

desired functionality of the automation device, various portions of the application code may not be used. For instance, an all-purpose or "universal" application program can be implemented wherein a standard executive code and user code for the control system exists within the application program for any desired network function. Due to the universality of the application code, the application code can be quite large. Some of the PLCs integrated with the network will not utilize all of the functionality provided within the standardized application program. Transferring and executing a large application program will affect the overall efficiency of the control system. The unnecessary use of storage space on the system, along with the additional time involved in transferring larger program codes, contributes to the inefficiency of the control system.

The present invention is provided to solve these and other problems.

#### Summary of the Invention

The present invention is directed to a control system comprising an automation device operably connected to a network. A network device is operably connected to the network and comprises an at least one predetermined application program for controlling the automation device. The application program is selected in response to a message requesting the application program that is sent by the automation device. The application program includes an executive code and a user code. Alternatively, the application program can be dynamic wherein the executive and user codes are selected in response to the message requesting the application program and/or the selected executive and user codes.

Another embodiment of the present invention is directed to a method of operating a control system on a network. An application program is stored on a network device operably connected to the network. A message requesting the application program is originated by the automation device. An application program is selected in response to the message requesting the application program. The selected application program is transmitted and installed on the automation

device. Alternatively, the program application comprises an executive and a user code. The user code is selected in response to the message requesting the application code. The executive code is selected in response to the selected user code. The selected user and executive codes are transmitted to the automation device for execution.

Other features and advantages of the invention, which are believed to be novel and nonobvious, will be apparent from the following specification taken in conjunction with the accompanying drawings in which there is shown a preferred embodiment of the invention. Reference is made to the claims for interpreting the full scope of the invention which is not necessarily represented by such embodiment.

#### Brief Description of the Drawings

FIGURE 1 is an illustration of a block diagram representing the present invention;

FIGURE 2 shows a block diagram of the present invention illustrating the relationship between an automation device and a network device for storing an application program to be executed on the automation device;

FIGURE 3 shows a block diagram of another embodiment of the present invention; and,

FIGURE 4 shows a block diagram of another embodiment of the present invention.

#### Detailed Description of the Preferred Embodiment

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail preferred embodiments of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to the embodiments illustrated.

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While this invention is susceptible of embodiments in many different forms, there is shown in the drawings and will herein be described in detail preferred embodiments of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to the embodiments illustrated.

A control system shown in FIGURE 1 includes an automation device 10 operably connected to a network 12. The automation device 10, preferably a programmable logic controller (PLC), can be operably connected to other PLCs 10 or input/output (IO) devices 16. The PLC 10 controls and monitors the IO devices 16. Depending on the desired application of PLC 10, the PLC can comprise different hardware and software code.

Other network devices 14, i.e., network personal computer, computer, input/output (IO) module 16, printer, etc., can also be operably connected to the network 12. A network device 14, preferably a server, stores one or more predetermined application programs 20 for use with the automation device 10. The application program 20 is selected in response to a message sent by the automation device 10 requesting the application program. Storing an array of application programs 20 within the network device 14 eliminates the need for the automation device 10 to store its own application programs.

An application program 20 comprises an executive code and a user code for the PLC 10, along with a boot up code. The application program 20 can be stored, created and edited using the network device 14 without requiring the resources of the PLC 10. In addition, a standard or universal application program 20 can be "customized" for a particular function or automation device 10. Thus, depending on the application program 20 required by the automation device 10, the network device 14 can provide the automation device 10 with an application program code that is specifically directed to the desired functionality. The request is generated

by the PLC 10 incorporating a dynamic host configuration (DHCP) or bootstrap (BOOTP) protocol.

Further customization of the application program 20 includes tailoring the executive program of the application program to meet the minimum criteria to effectively execute the application program 20. For example, a single, common, generic application program can reside in the server 14. Subject to the message request sent by the PLC 10 requesting the application program, unutilized sections of the code can be eliminated and parsed out from the generic application program prior to transmitting the selected application program to the PLC. In response to the message request for the application program, the server 14 selects a user code and an executive code. The user code can be selected in response to the message request for the application program. The executive program code can be selected in response to the user code selected and/or the message requesting the application program. Alternatively, several specific, predetermined application codes capable of interacting with any PLC 10 on the network can reside on the network device 14.

The "customized" executive and application program 20 codes improve the efficiency of the network 12 by decreasing the need for storage space on the automation device 10 and allowing for faster transfers of the application program 20 throughout the network 12. In addition, the need for Flash RAM on the automation device 10 to store the application program is significantly reduced. The PLC's Flash RAM will contain the minimum amount of code for downloading the executive and user codes from the network device 14. The application program code 20 for the PLC 10 is stored in the network device 14 and downloaded to the automation device 10 at boot time.

Although the preferred network 12 implementation is Ethernet, other network implementations can also be used such as Internet, Profibus, ControlNet and Modbus+. An application program 20 for controlling an automation device 10 is

stored on a network device 14 operably connected to the network 12. The PLC 10 sends out a BOOTP or DHCP request for obtaining an address on the network 12. A message request from the PLC 10 is transmitted to the network device 14, preferably a server, for acquiring the application program 20. The applicable application program 20 is selected and transmitted from the network device 14 to the PLC 10 in response to the message request for the application program. The application program 20 is then installed and executed on the PLC 10.

FIGURES 2-5 show block diagrams of the present invention illustrating the relationship between an automation device 10 and a network device 14, i.e., server, for storing an application program 20 to be executed on the automation device 10. The server 14 includes a network interface 22 having an unique network address 24 and an application program 20. The server 14 acts as a hypertext transfer protocol (HTTP) interpreter which uses a network protocol, i.e., Transmission Control Protocol (TCP) in conjunction with a Internet Protocol, through a Transmission Control Protocol/Internet Protocol (TCP/IP) stack to interact with the network interface 22 and the application program 20. This enables the transfer of the application program 20 to the PLC 10 through the network 12.

The application program 20 provides an operating program, i.e., executive and user codes; to the PLC 10. The executive code comprises a real time operating system 28, language support 30 and communication support 32. The user code 34 includes ladder logic or IEC 1131 code. The PLC 10 operating program can be stored, created or edited remotely from the PLC 10 and then transmitted to the PLC for use in the control system when desired. The TCP/IP stack enables data transfers over the network as by the IP protocol. The server 14 includes a program package 26 for editing and creating application programs 20. A user can access the program package 26 via a web page. The web page will display a home page which may contain text, some type of multimedia offerings such as graphic

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images, video, or audio, and hypertext links to other documents. A user using a browser can view the application program 20 via the web page and edit or create application programs 20 for use on the control system. The browser functions as a remote human-machine interface (HMI) with the network device 14 and the PLC's operating program 20.

It is understood by those skilled in the art that numerous changes and deviations in the form and detail thereof may be made without departing from the spirit and scope of the present invention. For example, the control system can incorporate a wireless network, or a network with a plurality of gateways and bridges. Similarly, the network device can be modified to include more components or to reduce the number of components. However, these variations do not depart from the scope of the present invention wherein network addressing is based, partly or completely, on the physical site location of the devices in the network.

Thus, the present invention has been described with respect to the preferred embodiments thereof. While specific embodiments have been illustrated and described, numerous modifications come to mind without significantly departing from the spirit of the invention and the scope of protection is only limited by the scope of the accompanying claims.